Issued November 27, 1909.

U. S. DEPARTMENT OF AGRICULTURE.

DIRECTOR OF AGRICULTURE
4 APR 1910
MADRAS.

FARMERS' BULLETIN 379.

HOG CHOLERA

BY

M. DORSET, M. D.,

Chief of the Biochemic Division, Bureau of Animal Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., September 15, 1909.

Sir: I have the honor to transmit for publication as a Farmers' Bulletin an article on "Hog Cholera," by Dr. M. Dorset, chief of the Biochemic Division of this Bureau. This paper is intended to supersede Farmers' Bulletin 24, "Hog Cholera and Swine Plague," published ten years ago, it having become desirable to replace that bulletin with one embodying the knowledge gained from the laboratory and field experiments which have in the meantime been carried on by the Biochemic Division.

The highly important discoveries concerning the cause and prevention of hog cholera have been more fully set forth from time to time in the publications of this Bureau. It is now well known that our laboratory experiments proved conclusively that the so-called hog-cholera bacillus was not the primary cause of the disease, this being attributed to an invisible (ultramicroscopic) organism. Having disposed of this point, it became our aim to devise some means of preventing the spread of the scourge, and for several years our efforts have been directed to the production of a serum that could be relied upon to immunize susceptible hogs, and this has now been successfully accomplished. Extensive field experiments have shown that the Bureau's preventive serum is definitely successful in combating hog cholera, under practical farm conditions. This result naturally created a large demand for the serum, so an attempt was made to interest the State authorities, particularly those in the hog-raising sections, with a view to having each State supply its farmers with reliable serum at a reasonable cost. The Secretary of Agriculture extended invitations to all the States to send representatives to the Bureau's experimental farm near Ames, Iowa, for conference on this subject, and more than twenty-five States were represented at three meetings held, respectively, in May, July, and October, 1908. Evidence of the efficacy of the serum was presented to the State representatives and the technique of preparing the serum was demonstrated. It is gratifying to report that several State institutions are now engaged in the manufacture and distribution of the serum.

Doctor Dorset has prepared this bulletin especially for the use of the practical farmer, in order that he may be enabled to recognize the disease and to deal with it effectively.

Respectfully,

A. D. Melvin,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

Agricultural College and Research Institute Library, Coimbatore.

REGISTER No.—

Circulated for perusal to--

1. The Director of Agriculture.

The Board of Revenue, Settlement.

The Honorary Secretaries, C. A. C.

2. The D. D. N. D.

3. The D. D. S. D.

Page.
..... 5
..... 6
..... 6
..... 6
..... 6
..... 8
..... 9
..... 15
..... 15
..... 15
..... 16
..... 16
..... 17
..... 17
..... 18
..... 18
..... 19
...... 20
...... 20
...... 20
...... 21
...... 22

Page.
.... 8
lera.... 10
used by
.... 13

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 15, 1909.

SIR: I have the honor to transmit for publication as a Farmers' Bulletin an article on "Hog Cholera," by Dr. M. Dorset, chief of the Biochemic Division of this Bureau. This paper is intended to supersede Farmers' Bulletin 24, "Hog Cholera and Swine Plague," published ten years ago, it having become desirable to replace that bulletin with one embodying the knowledge gained from the laboratory and field experiments which have in the meantime been carried on by the Biochemic Division.

The highly important discoveries concerning the cause and prevention of hog cholera have been more fully set forth from time to time in the publications of this Bureau. It is now well known that our laboratory experiments proved conclusively that the so-called hog-cholera bacillus was not the primary cause of the disease, this being attributed to an invisible (ultramicroscopic) organism. Having disposed of this point, it became our aim to devise some means of preventing the spread of the scourge, and for several years our efforts have been directed to the production of a serum that could be relied upon to immunize susceptible hogs, and this has now been successfully accomplished. Extensive field experiments have shown that the Bureau's preventive serum is definitely successful in combating hog cholera, under practical farm conditions. This result naturally created a large demand for the serum, so an attempt was made to interest the State authorities, particularly those in the hog-raising sections, with a view to having each State supply its farmers with reliable serum at a reasonable cost. The Secretary of Agriculture extended invitations to all the States to send representatives to the Bureau's experimental farm near Ames, Iowa, for conference on this subject, and more than twenty-five States were represented at three meetings held, respectively, in May, July, and October, 1908. Evidence of the efficacy of the serum was presented to the State representatives and the technique of preparing the serum was demonstrated. It is gratifying to report that several State institutions are now engaged in the manufacture and distribution of the serum.

Doctor Dorset has prepared this bulletin especially for the use of the practical farmer, in order that he may be enabled to recognize the disease and to deal with it effectively.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	5
Cause of the disease	6
The germ which causes hog cholera	6
Predisposing causes	6
Ways in which the hog-cholera germ reaches a herd	6
Symptoms of hog cholera	8
Appearance of a hog after death from hog cholera	9
Diagnosis	15
Diseases which may be mistaken for hog cholera	15
Sickness caused by improper feeding	15
Swine plague	16
Tuberculosis	16
Anthrax	17
Lung worms	17
Prevention and treatment of hog cholera	18
General preventive measures	18
Prevention by inoculation	19
Serum inoculation	20
Simultaneous inoculation	20
Safety of the methods	20
Practical tests of both methods	21
Conclusion	22

ILLUSTRATIONS.

	Page.
1. Hog sick of hog cholera (chronic type)	8
2. Showing location of organs which may be affected by hog cholera	10
3. Portion of large intestine of hog, showing button-like ulcers caused by cholera	13

HOG CHOLERA.

INTRODUCTION.

Hog cholera is an acute febrile disease which, so far as is known, affects only hogs, and which is characterized by extreme contagiousness and a very high death rate. It is usual to speak of two forms of this disease. One is called the acute and the other the chronic form. This is because of the fact that in some cases the disease is sudden in its onset and rapid in its course, whereas in others the affected hogs linger for weeks or months before death or recovery. Notwithstanding the dissimilarity in the symptoms and lesions observed in these two types of hog cholera, the causative agent is the same in both, the difference in the manifestations of the disease being no doubt due to a variation in the virulence of the germs which cause the disease, and possibly to some extent also to a variation in the resisting power of hogs.

Hog cholera is found in practically all parts of the world, and is especially prevalent in the large hog-raising districts of the United States. The first recorded outbreak in this country occurred in the year 1833 in the State of Ohio, and is supposed to have arisen through the importation of hogs from European countries, where the disease, no doubt, existed prior to its appearance in this country. From the original center of infection the disease has gradually extended to all portions of the United States, the spread being usually along the lines of transportation. Owing to the former limited facilities for communication between the Eastern and the Pacific Coast States, the latter section remained free of this disease until within the last few years, but reports received recently show that the disease now exists there, and at the present time no section of the United States may be regarded as free from hog cholera. Enormous losses are caused yearly in the large hog-raising States of the Middle West, and it may be safely said that several of these States lose yearly an average of more than $1,000,000 each from this source alone. While outbreaks may occur at all seasons of the year, the great majority take place during the late summer and fall. The mortality from hog cholera is as high as 100 per cent in some herds, while the average is probably from 70 to 80 per cent, and many of the hogs which survive are comparatively worthless, owing to their being weakened and stunted in growth.

CAUSE OF THE DISEASE.

THE GERM WHICH CAUSES HOG CHOLERA.

The germ or microbe which causes hog cholera is present in the blood of sick hogs and also in the excretions from such hogs, particularly in the urine. It has been shown that the disease can be produced almost without fail by inoculating well hogs with the blood or urine from sick hogs. The germ which is in this blood and urine is so small, or else of such structure, that it can not be seen with the strongest microscopes now available. It has never been cultivated in laboratories, as has been done with many other infectious germs, and we know of it only by the effects which it produces. The germ of hog cholera is therefore classed with the "invisible micro-organisms," and in this respect it resembles those which bring about a number of other diseases of animals and men, notably yellow fever, contagious pleuro-pneumonia, South African horse sickness, and foot-and-mouth disease.

PREDISPOSING CAUSES.

While the specific cause of hog cholera is the minute microorganism or germ just referred to, there are many factors which may render a herd more susceptible to the disease. In general, anything which tends to lower the health of the animals may be regarded as a predisposing cause. Among such predisposing factors there may be mentioned improper feeding, an insanitary condition of the hog lots, damp or cold sleeping places, and dirty drinking and feeding troughs. Of course insanitary surroundings and poor feed can not in themselves produce hog cholera, but they lower the vitality of hogs to such an extent that they become comparatively easy victims of any disease-producing germs to which they are exposed.

WAYS IN WHICH THE HOG-CHOLERA GERM REACHES A HERD.

Although the conditions just mentioned undoubtedly exert considerable influence upon the relative resisting powers of hogs to hog cholera, the disease can be started in a herd only by introducing the germ which causes it. This germ is always present in the bodies of sick hogs, and is thrown off from them in large numbers in the feces and urine, thus contaminating the yards or pens in which sick hogs are kept. The most dangerous factor in spreading hog cholera is, therefore, the sick hog; but any agency which might serve to carry a particle of dirt from infected yards may be the means of starting an outbreak of the disease.

Sick hogs may get onto a farm (1) by escaping from a neighboring herd, (2) by the purchase of new stock which may show no symptoms

of sickness until some days after purchase, (3) by returning show hogs to the herd after visits to fairs or stock shows, (4) by purchase of hogs which have apparently recovered from hog cholera. The risk incurred by purchase of new hogs or the return of hogs which have been shown at fairs is chiefly due to the fact that such hogs are generally transported by rail, unloaded in public stock yards, or driven along public roads. It is well known that sick hogs are frequently shipped by rail, and the roads over which they are driven, the stock yards, and the railroad cars thus become contaminated with the germs of hog cholera. When healthy hogs are placed in such cars or yards or driven along public roads they almost always have the opportunity to contract the disease, but the interval between shipment and delivery to the purchaser is so short that the symptoms do not appear until a week or more after delivery, when it is usually too late to prevent the spread of disease to hogs already on the farm. Obviously, the only safe plan in such cases is to place all new arrivals in lots entirely separated from those occupied by the main herd and to keep them isolated until all danger of their developing hog cholera has passed.

Aside from the danger of introducing infection through the hogs themselves it must be remembered that the germ of the disease, which as already stated is infinitesimally small, may be transported in a minute particle of dirt on the feet of attendants or neighbors who have previously visited farms where hog cholera exists. It may also be carried in this way by dogs, and by crows and other birds. It has been claimed, and considerable proof has been brought to show it, that the disease may be carried downstream from herds which are affected above. It is therefore well to avoid placing hogs so that they will have access to streams which pass through other farms. As diseased hogs are frequently transported by rail, it is quite possible for infection to be introduced into a farm by litter dropped from cars in transit, especially if hogs on the farm have access to the tracks.

After hog cholera has visited a farm, the lots, hog houses, feeding troughs, and implements used for cleaning have naturally become contaminated with the germs of the disease, and if new stock is placed in such yards soon after these were occupied by sick hogs the new hogs are very likely to contract the disease, but if such yards are left unoccupied the germs will die out after a while. Unfortunately it is not possible to tell with certainty just how long a time is required for these germs to die out, this uncertainty being due to the fact that conditions on different farms vary widely, and also because the weather conditions, which have an important influence upon the vitality of the hog-cholera germ, vary from time to time and in different sections of the country. In view of this uncertainty it is safest to wait as long

as possible before placing new hogs in lots that have been infected. Such premises should not be restocked sooner than three months after the last hog has been removed. Before restocking, the premises should be cleaned and thoroughly disinfected in the manner described under the heading "General preventive measures."

SYMPTOMS OF HOG CHOLERA.

The beginning of hog cholera in a herd is marked by the sickness of one or two hogs. There is nothing particularly characteristic in the symptoms displayed, and the presence of the disease may not be suspected until a week or two later, when other hogs are attacked. As the number of sick hogs increases the opportunities for

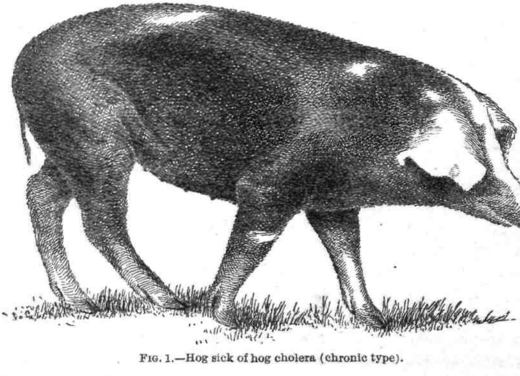

FIG. 1.—Hog sick of hog cholera (chronic type).

the well animals to contract the disease are multiplied, and in a comparatively short time all hogs exposed to the contagion will be attacked.

The symptoms observed in particular cases will be influenced by the virulence of the germ which is responsible for the attack, and also by the resisting power of the hogs in the herd. If this resisting power is low, or if the germ which is the cause of a particular outbreak is of high virulence, we may have in such a herd a typical manifestation of the acute type of hog cholera. In this acute type, the chief symptoms observed are sluggishness, disinclination to move, weakness, loss of appetite, a high fever, inflammation of the eyes with gumming of the lids, and there may be diarrhea. If the sick animals are examined carefully, red or purplish blotches may be seen on the skin, especially over the surface of the abdomen, on the inside of the legs, and around

the ears and neck. As a rule the progress of the infection is so rapid that the hog is not greatly emaciated before death; it is, in fact, usual in acute outbreaks for hogs to die after being sick only a few days.

In the chronic type of the disease the symptoms are quite similar to those seen in acute cases. The sick hogs are sluggish and disinclined to move when disturbed, and coughing is frequently heard when they are suddenly roused. They may eat very little and usually lose flesh rapidly, finally becoming so emaciated and weak that they stagger or walk with an uncertain gait, the hind legs particularly appearing to be very weak. (Fig. 1.) The eyes become inflamed and the lids may be gummed together. After the first few days of illness there is apt to be a profuse diarrhea, and in these chronic cases the hog may, and usually does, linger for several weeks, sometimes months, before it finally dies. It is extremely rare for such an animal to recover its health and vigor sufficiently to become of value to the owner.

It will thus be seen that before death the appearance of hogs affected with hog cholera is not particularly characteristic, for the symptoms, especially in acute cases, are only such as might be expected in a severe disease of any kind. But if these symptoms are noticed in a herd of hogs, and if the disease is seen to be contagious, showing a tendency to spread from the sick to the healthy animals, it is likely that hog cholera is present, though in order to be sure of this a post-mortem examination must be made.

APPEARANCE OF A HOG AFTER DEATH FROM HOG CHOLERA.

In regard to the examination of hog carcasses on the farm, it may be well to state that while hog cholera is not communicable to man, there is always danger of the hog being infected with other diseases, such as tuberculosis and anthrax, which are highly dangerous to man, and for this reason care should be exercised in examining carcasses of sick hogs so as to avoid a cut or scratch on the hands which might serve as a point for the inoculation of disease.

The post-mortem examination of a hog should begin with the skin, which may show the red or purplish blotches which have been mentioned above as one of the symptoms of hog cholera. When the examination of the skin has been made, the organs of the body are examined in the following manner: The hog is laid on its back, and, beginning at the throat, an incision is made along the middle of the chest and belly, through the skin and underlying fat, and extending the entire length of the body. The next step is to dissect back the skin of the chest so that the ribs are exposed. Now, beginning at the lower border of the ribs, about 1 or 2 inches on either side of the breast bone, and cutting toward the head, the ribs on both sides are

11034—No. 379—09——2

severed, the central portion, including the breast bone, being removed entirely. Crosswise incisions, extending from the first long incision toward each leg, are now made in the skin in such a manner that this may be laid back on both sides of the body, thus exposing to view the various organs which lie in the chest and abdominal cavities (see fig. 2).

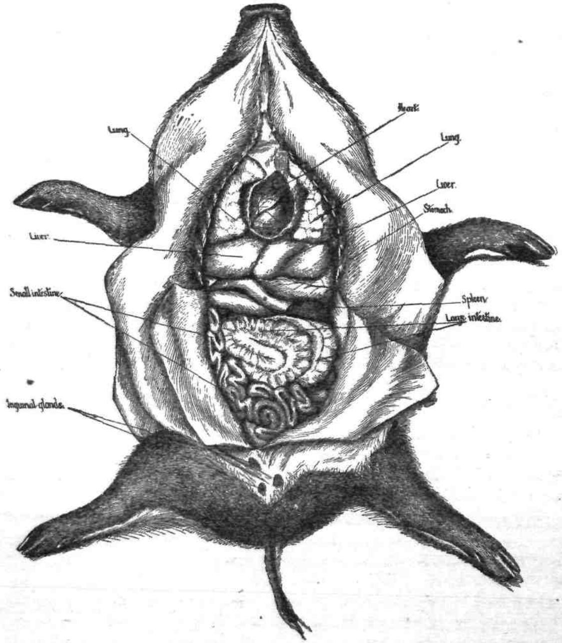

FIG. 2.—Showing location of organs which may be affected by hog cholera.

While the carcass is being opened, care should be taken to avoid injuring the organs. The important organs are examined as follows:

Lungs.—The healthy lungs are pink in color, soft, and filled with air. Occasionally, in that portion of the lungs nearest the neck, small, solid, dark areas may be seen in healthy hogs. Such areas without other lesions are not to be regarded as indicating hog cholera. In acute

cases of hog cholera the surfaces of the lungs frequently show numbers of small red spots of varying size which are caused by the rupture of minute blood vessels, thus allowing the blood to escape into the tissue. These spots can not be washed off with water and when found are an important indication of hog cholera. It is not unusual to find that large portions of the lungs are consolidated, and instead of being soft, filled with air, and pink in color, as is the case in normal lungs, the organs are heavy, solid, and of a grayish or dark-red color. This consolidation of the lungs is not so characteristic of hog cholera as the reddish spots mentioned above.

Heart.—The heart is inclosed in a thin membranous sac which can be easily slit open and removed so as to permit a satisfactory examination of the organ. In cases of hog cholera, the surface of the heart may show bloody-looking blotches similar to those seen in the lungs and which, like those in the lungs, can not be washed off with water. These bloody spots on the heart are rarely seen except in very acute and virulent forms of hog cholera.

Liver.—In cases of hog cholera the liver generally shows no marked change from the normal condition. It may be at times darker than normal in color, and if cut with a knife blood will exude. This indicates simply that the organ is congested. In some cases the liver may be of a light-grayish color, due to the increase of fibrous substances. Neither of these conditions is especially characteristic of hog cholera.

Spleen.—The spleen, or melt, which is found on the right-hand side of the hog's body as viewed at autopsy, lying a little below and to the right of the stomach, is in acute cases of hog cholera found almost without exception to be quite large, dark, and soft. In the prolonged, chronic cases, however, the spleen may be even smaller than normal and rather grayish in color.

Kidneys.—The kidneys, which lie beneath the intestines as viewed at autopsy, can be easily removed by pulling aside the soft fat and tissues which surround them and cutting the round tube which holds them to the body. The thin fibrous tissue which surrounds the kidneys should be carefully peeled off without cutting into or injuring the organ, and if the case is one of acute hog cholera, it is very likely that the normal light-brown color of the kidneys will be found to be changed to a much darker color, and there may be seen over the surface a number of very dark-red points, some of these no larger than a pin point, whereas others may be larger than the head of a pin. The appearance of the kidneys frequently reminds one of the speckling of a turkey's egg. These spots are caused by the escape of blood from the small blood vessels in the same way as the larger reddish spots which occur in the lungs and on the heart. Both kidneys should be examined.

Stomach.—The stomach is the large white pouch-like organ which is situated in the upper part of the abdominal cavity next to the lungs and by the side of and partly underneath the liver. Usually the external surface of the stomach shows no change from normal, though occasionally there may be observed small red spots similar to those which have been described as appearing in the lungs, heart, and kidneys. The stomach should be opened by cutting the front wall from one end to the other. The partly digested food which is usually found within the stomach is removed and water poured in so as to clean the inner surface and permit a satisfactory examination. The normal stomach lining is a uniform, rather wrinkled, pinkish-looking membrane. It is smooth and free from distinct hemorrhages. In cases of hog cholera it is not infrequent to find large portions of this lining membrane of the stomach very much inflamed and red, and a careful examination will frequently show that this lining membrane has been ulcerated. The ulcerated portion usually extends over a considerable area of the lining membrane of the stomach and is separated from the healthy portion by a more or less distinct line.

Small intestine.—The intestines are connected directly to the stomach. The small intestine is that portion which begins at the stomach and continues until a distinct union is made with a portion of the large intestine known as the cecum or blind gut. In normal hogs both the outer and inner surfaces of the small intestine resemble considerably those of the stomach, though of course the walls of the intestine are not nearly so thick. The small intestine is well supplied with small blood vessels which can be distinctly seen. In some acute and virulent types of hog cholera the outer surface of the small intestine may be literally covered with bloody spots, giving one the impression that blood had been spattered over these organs, but upon washing them with water it will be found that these bloody areas can not be removed. There is no other characteristic lesion of the outer surface of the small intestine. The inner lining, however, may at times, in cases of hog cholera, be congested and inflamed, so that the normal wrinkled inner surface is greatly thickened and covered with a yellowish exudate or coating, or it may be dotted with small bloody spots like those seen on the outer surface of the intestine.

Large intestine.—The large intestine differs markedly from the small intestine in general appearance, being larger in circumference and of more uneven surface. The appearance of the large and small intestines in health and their relative positions in the body are shown in figure 2. In cases of hog cholera the outer surface of the large intestine may show the same hemorrhagic spots that have been mentioned as occurring on the small intestine, but it is the inner lining that shows the most important changes.

In acute cases of hog cholera the inner lining of the large intestine is frequently found to be blood stained and small areas of a bloody extravasation are seen. It is also frequently found that the feces con-

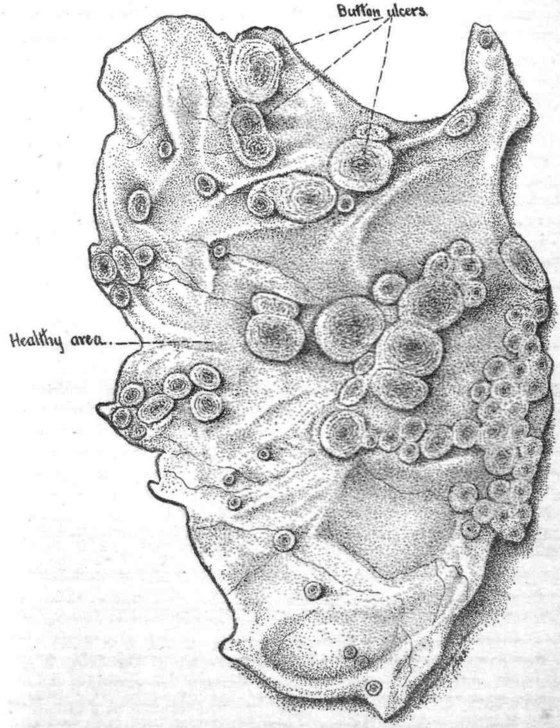

FIG. 3.—Portion of large intestine of hog, showing button-like ulcers caused by cholera.

tained in the large intestine are bloody, due to blood having escaped from the bleeding portion of the intestine. In the case of hogs which do not die quickly from the disease—that is, in chronic cases—we are

apt to find on the inner surface of the large intestine what are generally regarded as the most characteristic lesions of hog cholera. These are the so-called "button" ulcers. These ulcers are usually round, hard, and yellowish, with a dark center, and are distinctly raised above the surrounding healthy inner surface of the large intestine. They vary greatly in size, some being very small points, whereas others are larger than a silver 25-cent piece. Once these lesions have been seen, they can not be mistaken afterwards. A very good idea of their appearance is given in figure 3.

The finding of the typical button ulcer may be considered as a positive indication of hog cholera, and it is the only lesion that can be regarded as absolutely diagnostic, though the bloody points or hemorrhages in the kidneys, heart, and other organs of hogs are rarely seen in diseases other than hog cholera in the United States.

Lymphatic glands.—Aside from the lesions of the various organs which have been described, the changes which take place in the lymphatic glands of a hog that has died from hog cholera are of much importance. These glands are found in different parts of the body. The most important ones to be examined are those in the inguinal region; these will be readily found and recognized by the farmer. These glands are situated in the fat just under the skin of the abdomen, near the median line of the body, and between the hind legs (see fig. 2). These glands, if normal, will be found to be of a rather light-grayish color. After normal glands have been seen, the changes which occur in cases of hog cholera will be readily recognized. These changes consist chiefly in an enlargement of the glands together with a marked reddening. At times these glands are so red as to appear almost black, and if they are cut through with a knife it will be found that the exterior or rind is the portion chiefly affected. Other lymphatic glands which undergo a change of this kind in hog cholera are found at the angles of the lower jaw, in the neighborhood of the heart, and beneath the liver and stomach.

Summary of post-mortem appearances.—To recapitulate, then, the important lesions found after death from hog cholera are as follows:

1. Reddening of the skin.

2. Bloody spots in the lungs, on the surface of the heart, in the kidneys, on the outer surface and inner lining of the intestines and the stomach.

3. Reddening of the lymphatic glands.

4. Enlargement of the spleen.

5. Ulceration of the inner lining of the large intestine.

Any one or all of these lesions may be found in a hog which has died from hog cholera. It is rare to find all in any individual case, although at times we do find a perfectly typical picture showing all of

the lesions described above. On the contrary, it has also been noticed that hogs suffering with a virulent form of hog cholera may at autopsy show only an enlarged spleen or a hemorrhagic or bloody condition of the lymphatic glands. In the *lingering or chronic cases* of hog cholera it is usual to find the intestinal button-like ulcers, while the hemorrhagic lesions described above are, as a rule, absent.

DIAGNOSIS.

From what has already been said of the symptoms exhibited by *hogs sick of hog cholera, it will be recognized that at the beginning* of an outbreak in a herd it is a difficult matter to be sure that hog cholera is actually present, for the outward symptoms are not characteristic, but only such as might be expected in any acute disease. The same may be said of some of the changes which take place in the internal organs. It is therefore necessary to consider all of the features of the disease before making a positive decision concerning the presence or absence of hog cholera in a herd.

The important features of hog cholera are:

1. Contagiousness.
2. Symptoms of severe illness, such as fever, weakness, loss of appetite, and diarrhea.
3. Hemorrhagic spots in the internal organs or button-like ulcers in the intestines. (See figs. 2 and 3.)

If these characteristics are found in a disease of hogs in this country, we may be reasonably certain of the presence of hog cholera.

DISEASES WHICH MAY BE MISTAKEN FOR HOG CHOLERA.

Among the few diseases which may lead to uncertainty are digestive troubles (due to improper feeding), swine plague, tuberculosis, anthrax, and inflammation of the lungs caused by worms.

SICKNESS CAUSED BY IMPROPER FEEDING.

Although hogs are frequently made sick by improper feeding, there is rarely any cause for mistaking such illness for hog cholera, the only trouble of this character which is likely to give rise to confusion being in the case of swill-fed hogs. Dr. V. A. Moore has reported a disease among swill-fed hogs which closely resembled hog cholera and which was directly traceable to the presence of powdered soaps in the slops. Some of these soaps contain a large amount of alkali, and when mixed with the garbage used for feeding hogs will bring about lesions in the internal organs *which are very similar to*

those seen in hog cholera. In most cases it will probably not be difficult to distinguish such a disease from hog cholera, especially if the mode of feeding be considered. If the illness is due to the presence of alkali in the swill, a change of food should result in a prompt improvement in the condition of the animals. If this does not occur, then, of course, hog cholera or some other germ disease should be at once suspected.

SWINE PLAGUE.

It is not practicable for a farmer to attempt to distinguish between hog cholera and swine plague, for, while swine plague is generally regarded as a lung affection, and hog cholera as a disease of the intestines, the fact is that practically all of the lesions which are found in cases of hog cholera have also been reported as being present in outbreaks of swine plague. There is at present a tendency on the part of those who have investigated these diseases to regard both hog cholera and swine plague as being caused by the same invisible germ, the predominance of lung lesions in one case and intestinal inflammation in the other being caused by the action of different germs which attack the hog after it has been made sick by the invisible germ which is looked upon as the prime cause of the disease in both cases. However this may be, it is quite safe to say that the great losses which occur among hogs in this country are brought about by hog cholera, and that, for the present at least, we may ignore the existence of swine plague as a separate disease, especially as the general measures for controlling it are the same as those required in cases of hog cholera.

TUBERCULOSIS.

The distinguishing features between hog cholera and tuberculosis are that in the case of tuberculosis the onset of the disease is slow rather than sudden, as is the case in hog cholera; likewise the progress of the disease is very slow, and the symptoms exhibited by the hogs which are affected are those of general unthriftiness rather than of acute illness. Tuberculosis does not show a tendency to spread rapidly through a herd of hogs, as is the case in hog cholera, and the deaths, if any occur, will in the vast majority of cases follow a very prolonged illness. It is extremely rare that an apparently healthy hog will die quickly from tuberculosis. It is possible, of course, for a whole herd to show signs of tuberculosis at about the same period, because of having previously contracted the disease from the same source and at the same time, as, for instance, through the feeding of tuberculous skim milk. But in this case the hogs have caught the infection from the skim milk, and not from each other.

In cases of tuberculosis the post-mortem changes which may be found in the organs consist of whitish or grayish consolidated areas in the lungs, with sometimes a yellowish cheesy-like center. Similar areas, though not so large, are found in the liver, and in the case of the spleen we find nodules of varying size, some as large as an acorn. These nodules project above the surface of the spleen. They are whitish looking, and when cut are found to be of a tough, fibrous nature, the appearance of this organ being entirely different from that found in hog cholera. In tuberculosis the bloody points in the kidneys are absent, but ulcerations may be found in the intestines. These are usually in the small intestine rather than in the large intestine, and instead of being round and raised and button like, as in hog cholera, they are rather irregular in outline and depressed below the surface of the surrounding healthy tissue, indicating a destruction or eating away of the inner lining of the intestines.

Tuberculosis frequently affects the lymphatic glands, but the changes which this disease causes can hardly be mistaken for lesions of hog cholera, for in tuberculosis the inner portion of the gland is broken down to a yellowish, cheesy mass which is not at all like the lesions of hog cholera.

ANTHRAX.

Hogs are rarely affected by anthrax, but when this disease does occur it might be readily mistaken for the acute type of hog cholera. The distinguishing features of anthrax in hogs are the marked swelling of the throat and tongue, with frequently a bloody froth in the mouth, and further by the fact that anthrax in hogs usually follows disease in other animals on the farm, horses, cattle, and sheep being more susceptible to anthrax than hogs.

LUNG WORMS.

Young, growing pigs are at times attacked by lung worms, which bring about an inflammation of the air passages. The most important symptoms produced by these are general unthriftiness, and a hard cough. Old hogs are rarely attacked and the younger hogs usually recover. The worms that produce this trouble are very small (one-half to 1 inch in length) and examination of the frothy expectoration of sick hogs or of the lungs after death is usually required to make a positive diagnosis. In this disease there is an entire absence of symptoms of acute illness such as usually accompany an attack of hog cholera. This fact coupled with the cough would point to lung worms; examination of the lungs and expectoration with a magnifying glass will serve to clear up doubtful cases.

PREVENTION AND TREATMENT OF HOG CHOLERA.

GENERAL PREVENTIVE MEASURES.

All that is necessary to prevent hog cholera is to keep the germ of the disease away from the herd. It has been shown that in the vast majority of cases this germ is transported mechanically, in the bodies of sick hogs and on the feet of men or animals, including birds. It thus follows that the chances of an outbreak of hog cholera will be greatly lessened, if not completely avoided, if a herd is protected from these carriers of the infection. The enforcement of a complete quarantine is, however, not practicable under average farm conditions, and the best that can be hoped for is the lessening of the opportunity for infection by placing the herd on a part of the farm that will be the least accessible to men or animals from other farms. Hog lots should never be located near public roads if this can be avoided. All newly purchased stock should be kept separate from the main herd for at least thirty days.

In addition to protecting the herd by methods of quarantine, careful attention should be given to the general health of the herd. The hogs should be provided with clean, dry sleeping places, and the lots and feeding-troughs should be kept clean. It is well occasionally to scatter slaked lime about the lots and to wash and disinfect the troughs. Probably the best disinfectant for this purpose is the compound solution of cresol (U. S. P.), which can be prepared at any drug store. One part of this should be mixed with 30 parts of water and the troughs scrubbed with it. The disinfectant is then washed out of the troughs with water.

After an outbreak of hog cholera the yards and pens should be thoroughly cleaned, all dead hogs should be burned or buried deep with quicklime, the litter should be collected and burned, and lime scattered freely over the ground. The sheds and hog houses should be washed thoroughly with the solution of cresol as above described before new stock is brought on the place. Feeding troughs that have been used by sick pigs should be burned if made of wood, but if this is not practicable they should be scrubbed clean and thoroughly soaked with the cresol solution, the latter being washed out before the troughs are used again.

It is possible to start an outbreak of hog cholera in a herd by bringing hogs on the farm that have had the disease and have apparently recovered. We have no definite information concerning the length of time that such hogs may be able to communicate the disease to others, but for safety's sake two or three months should be allowed to elapse after complete recovery before placing such an animal with susceptible pigs, and then only after washing or dipping in a disinfectant solution (compound solution of cresol, 1 to 100).

In Farmers' Bulletin 24, Dr. D. E. Salmon gave the following formula for a medicine which was used many years ago as a preventive and cure for hog cholera:

	Pounds.
Wood charcoal	1
Sulphur	1
Sodium chlorid	2
Sodium bicarbonate	2
Sodium hyposulphite	2
Sodium sulphate	1
Antimony sulphid (black antimony)	1

Experience has shown, however, that this medicine is not to be regarded as a cure or preventive in the true sense of the words, but it is nevertheless a very good condition powder. This powder is mixed with the feed in the proportion of a large tablespoonful to each 200 pounds weight of hogs to be treated, and should not be given oftener than once a day. This medicine can not be relied upon to prevent the occurrence of disease, except in so far as it improves the general health of the hogs. Therefore, even though this remedy be used, strict attention must be given to quarantine and sanitary measures if the disease is to be warded off when in the neighborhood.

PREVENTION BY INOCULATION.

Careful and persistent attention to general preventive measures, such as quarantine, disinfection, proper feeding, etc., on the part of farmers generally would no doubt result in a material reduction in the yearly losses from hog cholera, and the importance of observing these precautions can not be overestimated. However, as it is regarded as impracticable to enforce a general and completely effective quarantine, the Bureau of Animal Industry has endeavored for a number of years to find a medicine or serum which could be used for preventing hog cholera or for curing hogs sick of that disease. It is a well-known fact that hogs which have recovered from hog cholera are thereafter immune against that disease. The experiments of the Bureau of Animal Industry resulted in the discovery that when such immunes are injected with blood from a sick hog the immune is not made sick, but as a result of this injection its blood acquires the power to protect other hogs from hog cholera. The details of the early experiments which served to establish this fact are given in Bureau of Animal Industry Bulletin 102.[a] Since that bulletin was issued a great deal of additional work has been carried out, and it has been established beyond question that the early observations were correct and that it is entirely possible to protect hogs if they are treated with serum from a properly treated immune hog.

[a] Can be obtained only from Superintendent of Documents, Government Printing Office, Washington, D. C.; price, 15 cents.

The method of producing this serum is briefly as follows:

A vigorous immune hog—that is, one which has recovered from an attack of hog cholera or one which has been exposed to the disease without contracting it—is treated with a large quantity of blood from a hog sick of hog cholera. After a week or two blood is drawn from the immune by cutting off the end of the tail. After standing, the blood clot is removed and the serum or fluid portion of the blood is mixed with a weak solution of carbolic acid and filled into sterilized bottles. *We have in this fluid portion of the immune's blood the* serum which will protect hogs from hog cholera. This serum is used in either one of two ways, namely, (1) the serum inoculation, and (2) the simultaneous inoculation. These two methods of treatment are carried out as follows:

Serum inoculation.—The hogs which are to be protected are injected on the inside of the hind leg with a suitable dose of the serum alone. *This injection will serve to protect hogs from hog cholera for several* weeks and, in some cases, for a longer time. But if the hog is not exposed to hog cholera within a few weeks after this treatment, the immunity which is conferred by the serum will gradually lessen in degree and the hog may again become susceptible. If, however, the hog is exposed to hog cholera within a short time after the injection of the serum, the immunity becomes, so far as experiments have shown, *of permanent and lifelong duration.*

From what has been said it will be seen that the injection of the serum alone is especially to be recommended in cases where there is immediate danger of exposure, especially when valuable hogs are carried to fairs and in herds where the disease has already broken out but has not progressed very far. In herds of this character all of the well animals may be treated, and even in the case of slightly sick animals much good may be accomplished by the serum injection.

Simultaneous inoculation.—In this form of vaccination the same serum is used as is employed when the serum alone is used, but in addition to the serum there is injected on the opposite side of the body, in the same manner as the serum, a very small amount of blood taken from a hog sick of hog cholera. This simultaneous injection of serum and virulent blood confers upon the injected pig a permanent and lasting immunity, and is therefore to be recommended in cases of well herds which may not be exposed for some months after the treatment.

Safety of the methods.—Properly prepared serum when used alone, *without the employment of blood from a sick hog,* is entirely harmless and incapable of giving rise to an attack of hog cholera. Nor does this injection interfere in any way with the growth of the treated hogs.

The simultaneous inoculation, involving as it does the use of a disease-producing virus, requires much more care when employed than does the serum-alone inoculation, for, if through careless preparation or from any other cause the serum should be weaker than is required, injury to the vaccinated hog might result. This danger, which is extremely slight when carefully tested serum is used, is met with in practically all processes which are now employed for producing a permanent and lasting protection against infectious diseases, and although it would be very desirable to eliminate even this slight element of danger, we can hardly expect to do this without at the same time sacrificing to some extent the high degree of immunity and the prolonged protection which follows the simultaneous method in its present form.

Practically, in deciding which method to use one must be governed largely by the length of immunity which is required. If this is needed for only a few weeks, or if the treatment can be repeated at short intervals, as in the case of exceptionally valuable pure-bred hogs, where the increased cost would not be objected to, the serum alone may be used. In other cases the simultaneous method is recommended. In either process of vaccination it is considered highly desirable for the treatment to be applied by competent veterinarians who have had special training in this class of work, and only such skilled men should employ the simultaneous process. After treatment by the simultaneous method the herd should be kept under observation for ten days or two weeks, and if any of the inoculated hogs show serious symptoms of disease the herd should be immediately re-treated with the serum alone. When properly performed, the simultaneous inoculation does not seem to injure the hog or to interfere with its growth in any way, and if the precautions indicated above are taken it is regarded as safe enough for practical use.

Practical tests of both methods.—As before stated, the serum has been tested by the Bureau of Animal Industry in an extended manner on farms under practical conditions, both the serum inoculation and the simultaneous inoculation being employed at different times. In these practical experiments a number of hogs were generally left untreated, so that we might be sure that the herd actually had hog cholera and also be able to determine better the action of the serum. In these tests approximately 2,000 hogs, located on 47 separate farms, were treated. Some of the herds treated were apparently perfectly well at the time, but were in a neighborhood where hog cholera was prevalent. In other cases the disease was just beginning, as indicated by the sickness of one or two animals. In others the disease had progressed to a considerable extent, a number of the animals

in the herd being sick at the time of treatment; and in still another class of herds the hogs had been exposed to disease by contact with sick animals, but had not developed symptoms of illness at the time of treatment. The tests were carried out under farm conditions, and aside from the serum injections no attempt was made to save the treated hogs. Upon summarizing the results at the end of the season it was found that more than 85 per cent of the treated hogs had been saved in herds that were sick at the time of treatment, while of the hogs left untreated in the same herds only 25 per cent survived; more than 95 per cent of the treated animals were saved in the herds which had been exposed at the time of treatment, while of the untreated hogs in the same herds only 11 per cent survived; of the treated hogs in the herds that did not become exposed until after the treatment none were lost, whereas only 35 per cent of the untreated hogs in the same herds survived.

While in practice the serum may not always give as good results as these, there can be no doubt that if used properly and in the early period of an outbreak of hog cholera it will effect a very large saving.

CONCLUSION.

Since these results were obtained the Department has brought this method of preventing hog cholera to the attention of the various State experiment stations and live-stock sanitary boards throughout the country and has proposed to them that they take up this work and prepare a serum for the benefit of hog raisers, as the preparation of serum by the Federal Government on a large enough scale to supply the needs of the entire country seemed to be impracticable. As a result of this, a number of the States have taken up the work, and in practically all cases where a thorough test has been made they have confirmed the results obtained by the Department with this method. We therefore feel safe in saying that this process will prevent hog cholera, provided due care is given to the preparation of the serum and to its application.

The serum preparation is of such a nature that it should not be undertaken by farmers themselves, but should be under the control of trained men who have had experience in bacteriology and who are also thoroughly familiar with the diseases which affect hogs. For these reasons no attempt has been made in this paper to describe the details of the serum production.

At the present time it is impossible to state definitely just what the cost of this serum should be. This will undoubtedly vary in different localities, depending upon local conditions, such as the price of hogs, the cost of feed, and similar minor considerations; but it has been esti-

mated, and this estimate has been confirmed by at least one of the States now conducting this work, that the serum can be made for 25 cents a dose. We do not regard this as the minimum limit of cost for the serum production, but rather hope that with increased knowledge of the disease and wider experience with the serum production this estimate will be materially reduced.

Finally, it should be remembered that this serum is to be used especially as a preventive, and that little success can be expected in herds which are badly affected with hog cholera. An early application is essential, and in the States which have taken up this work the farmers should notify the proper authorities immediately upon their hogs becoming ill, so that they may be treated at once.

Inasmuch as the serum described herein is a comparatively new substance, it is not to be expected that success will always follow its use, but as it has been already definitely proved that hog cholera may be prevented with this serum, the failures, if they occur, will be caused by local conditions or variations in the details of serum production, which can be corrected. Those who are interested in the subject are urged to cooperate with the State authorities who have control of this work and to assist them in their efforts to produce a reliable serum. *It is only through such intelligent cooperation* that we can expect to attain the final result which is aimed at, namely, the eradication of hog cholera as a serious menace to the hog-raising industry in this country.

NOTE.—The United States Department of Agriculture is not preparing anti-hog cholera serum for distribution. Those who wish to obtain serum should apply to their respective State veterinarians or agricultural colleges.